Patent Claims

1. Method for calibrating an ultrasonic flow measuring device (1), which includes a measuring tube (2), at least two ultrasonic sensors (3, 4; 5, 6) and a control/evaluation unit (17), wherein the ultrasonic sensors (3, 4; 5, 6) emit and/or receive ultrasonic measuring signals, wherein the flow of a medium in the measuring tube (2) is determined on the basis of the travel times of the ultrasonic measuring signals, which traverse the measuring tube (2) in the stream direction (S) and counter to the stream direction (S),
wherein information concerning the theoretical flow of the medium through the measuring tube (2) is won on the basis of predetermined, geometric, production data of the flow measuring device (1),
wherein actual, geometric measurement data of the flow measuring device (1) is determined three-dimensionally,
wherein information concerning the actual flow of the medium through the flow measuring device (1) is won on the basis of the actual, geometric measurement data, and
wherein a correction, or calibration, factor is determined for the flow measuring device (1) on the basis of the information concerning the theoretical flow, and the actual flow, of the medium through the flow measuring device (1).

2. Method as claimed in claim 1,
wherein the actual, geometric measurement data is determined by a three-dimensional scanning of the flow measuring device (1).

3. Method as claimed in claim 2,
wherein the scanning of the flow measuring device (1) is performed by means of electromagnetic waves or by means of a mechanical scanning head (16).

4. Method as claimed in claim 2 or 3,
wherein the flow measuring device (1), or the measuring tube (2), is simulated by a mathematical model.

5. Method as claimed in claim 4
wherein, in the mathematical model, the following variables are taken into consideration:

- the angle of incidence and/or angle of emergence between ultrasonic sensor (3, 4; 5, 6) and the medium;
- the separation (S1; S2) between two sound emitting, respectively two sound receiving, surfaces of the ultrasonic sensors (3, 4; 5, 6), which alternately emit and receive;
- the radial separation H of the sound paths of the ultrasonic measuring signals of two ultrasonic transducers (3, 4; 5, 6) about the central axis of the measuring tube (2);
- the positions of the emitting and receiving surfaces of the ultrasonic sensors (3, 4; 5, 6) relative to the flowing medium or to the inner wall of the measuring tube;
- the cross sectional area A of the section of the measuring tube (2) lying between the two ultrasonic transducers (3, 4; 5, 6) and flowed-through by the medium.

6. Method as claimed in claim 2 or 3,
wherein the actual inner cross sectional area of the measuring tube (2) is determined by measuring the three-dimensional coordinates of a plurality of scanning points lying in at least

two parallel cross sectional planes (9, 10) of the measuring tube transverse to the stream direction (S) of the medium.

7. Method as claimed in claim 2 or 3 or 5,
wherein the three-dimensional coordinates of the sound emergence, respectively sound incidence, surfaces of the ultrasonic sensors (3, 4; 5, 6) are determined.

8. Method as claimed in claim 7,
wherein, for the purpose of determining the three-dimensional coordinates of the midpoint of the sound emergence, or sound incidence, surface of an ultrasonic sensor (3, 4; 5, 6), a setup gage (13, 15) is used, in which, instead of an ultrasonic transducer, a cone (14) of defined shape is used, which is so embodied, that the midpoint of a ball (16) of defined diameter lies in the midpoint of the sound emergence, or sound incidence, surface of the corresponding ultrasonic sensor (3, 4; 5, 6), when the ball (16) contacts the cone (14).

9. Setup gage (13, 15) for performing a method as claimed in one or more of the claims 1 to 8,
wherein, instead of the ultrasonic transducer, a cone-shaped element (14) is used, which is so dimensioned, that the midpoint of a ball (16), whose diameter corresponds to the diameter of a scanning head of a mechanical scanning device, lies in the midpoint of the sound emergence, or sound incidence, surface of the ultrasonic sensor (3, 4; 5, 6), when the ball (16) contacts the cone-shaped element (14).

10. Setup gage (13, 15) for carrying-out the method as claimed in one or more of the claims 1 to 8,
wherein, instead of the ultrasonic transducer, a retroreflector element is provided, which is so embodied, that impinging electromagnetic radiation from a scanning device is reflected back, into the scanning device.